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Directions for using big data analytics in logistics management

Dinara Aubakirova*
HR-manager
ZALMA Ltd. LLP
050009, 305A Bogenbai Batyr Str., Almaty, Republic of Kazakhstan
https://orcid.org/0009-0000-8878-7570

Abstract. Logistics operations are becoming increasingly complex and require accurate data for effective management. The use of big data in logistics management is a relevant issue due to the growing volume of data and the need to optimize delivery and inventory management processes to meet market demands. The purpose of the study was to develop ways to optimize the management of big data analysis in logistics. To achieve this goal, the methods of analysis, experimentation, and comparison were used. As a result of the study, strategies for optimizing logistics management of big data analysis were developed and successfully applied. The Python programming language based programme effectively optimizes delivery routes using a clustering algorithm and visualizes the results of this process. Additionally, an informative diagram has been drawn up to illustrate the key stages of the developed strategies. The study also developed and presented a table describing the use of big data analysis methods in various logistics companies. The companies were compared in terms of functionality, data, results, and field of activity. It is established that the use of machine learning methods and optimization of data storage and processing significantly increases the efficiency of logistics operations. The results of this study can be used by logistics companies of any size, as well as enterprises engaged in supply chain management. In addition, the recommendations and strategies developed in this study may be useful for information technology and data analytics professionals involved in the development of software solutions and systems to optimize logistics processes

Keywords: supply control; use of volumetric information; ways to optimize management; transport and warehouse organization; big data analysis

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INTRODUCTION

The study of the directions of using big data in logistics management is an important task in the modern business world. With the growing volume of data and complexity of logistics operations, there is a need for effective information management to ensure operational efficiency and competitiveness of companies. In the rapidly changing economic and competitive environment of the logistics market, the use of advanced analytical tools and techniques such as big data analytics, machine learning and Internet of Things (IoT) is becoming key to ensure competitiveness and efficiency in logistics operations. Unlike traditional analytics, new techniques can process and analyse large amounts of data in real time, identify hidden patterns and predict trends, giving companies an edge in making strategic decisions and optimizing operations. Thus, the use of advanced analytical tools becomes a prerequisite for successful operations in today's logistics environment.

There are many other studies that have addressed this topic and attempted to address the challenges associated with managing big data analytics in logistics. For example, S.K. Serikbayeva *et al.* (2021) noted that modern data technologies have a significant impact on logistics management, providing new opportunities for optimizing processes. The introduction of big data in logistics is accompanied by increasing demands for effective information management and productivity improvement. Research in this area includes analysing data processing methods and defining the requirements for the information system of a logistics company. In their paper, G. Zhanbirov & E. Zhanbirov (2022) stressed that efficient organization of

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*Corresponding author

production operations plays a key role in the dynamics of the logistics system by minimizing costs and synchronizing processes. Standardization of material resources helps to improve production performance and reduce storage and picking costs. A flexible supply chain provides a balance between reliability and cost-effectiveness in a highly dynamic logistics management environment.

In a study by S. Abdikul *et al.* (2022), the prospects of using digital technologies in supply chain management were examined, particularly the integration of blockchain technology in logistics. Supply chain management processes are focused on optimizing virtualization and the development of the digital economy. In this context, the application of blockchain technologies is seen as a means to improve the management of supply chain processes by providing transparency and security of transactions, which can be beneficial for efficient business management and logistics systems. A. Userbayeva *et al.* (2022) emphasized that strategic management helps companies to succeed in the long term through effective logistics, which plays an important role in achieving business goals. The authors emphasized that the development of logistics strategies and infrastructure is of high importance for the economic growth of a country. In turn, Z. Alimova *et al.* (2023) discussed a project funded by the government of Kazakhstan through the Ministry of Science and Higher Education to create an algorithm and software for data analysis. Modern technologies allow efficient collection and storage of data in digital format. However, specialized computer analytics tools and techniques are required to extract useful information from this data. Researchers N.K. Mukazhanov & A.M. Tolegenov (2022) described the creation of a data model and its visualization in a logistics information system for strategic and operational management. The authors described visualization methods that allow quick access to multidimensional data, as well as software for storing and analysing information.

In addition, R. Karki *et al*. (2024) emphasized that data analytics in logistics and supply chain management is attracting more and more attention from companies. It has the potential to improve supply chain performance, but many companies have not yet fully utilized these capabilities. The author noted that it is important to investigate the factors affecting supply chain performance and understand which ones can be optimized using big data analytics. The study by Z. Chen & Z. Liao (2023) revealed that the use of data analytics and artificial intelligence-based solutions can improve the warehouse management efficiency of logistics companies as well as optimize the entire supply chain. Big data can accurately forecast demand and coordinate supply chain operations, which helps improve cost control and resource utilization. However, the application of big data can raise ethical concerns in the logistics industry, which negatively affects the security of information and personal safety of customers and logistics companies.

Previous studies have raised issues related to this topic, but challenges such as effective information management, performance optimization and digital integration remain unresolved. With the increasing volume of data and complexity of logistics operations, it is becoming increasingly difficult to manage information effectively, making it difficult to make informed decisions and reducing the operational efficiency of companies. The challenge is also the diversity of data sources, formats, and structures, which not only makes it difficult to make informed decisions, but also creates difficulties in adapting to rapidly changing market conditions. New customer requirements and expectations reinforce the need for a more flexible and adaptive approach to data management in logistics. The development of new data management strategies becomes a necessity to improve the operational efficiency and competitiveness of logistics companies, which emphasizes the relevance of this issue in modern logistics. With this in mind, the aim of the research was to create effective methods for managing big data analysis in logistics.

MATERIALS AND METHODS

To achieve the research objective, a comprehensive methodological approach was used, including such methods as analysis, experimentation, and comparison. The method of analysis allowed for an in-depth investigation of relevant aspects of big data management and analytics in the context of logistics. This research not only analysed the current trends, issues, and challenges faced by logistics companies, but also explored existing strategies and approaches to data management in this sector. This method allowed for a more detailed examination of various aspects of data processing, including its dynamics within logistics systems, the application of blockchain technologies and virtualization, as well as exploring strategic management, computer analytics techniques and data models. The method of analysis covered a wide range of technological innovations and solutions used in logistics. This included the study of supply chain management, application of big data in omnichannel logistics, analysis of bibliometric data, application of artificial intelligence, impact of e-commerce on logistics operations, various technological and organizational solutions. An equally important aspect of the study was to examine the impact of IoT on logistics processes, as well as to analyse trends related to the development of Industry 4.0. Various innovative business models were also explored, including their application in the logistics context, as well as the impact of the use of big data and machine learning techniques on the field of mergers and acquisitions in the logistics sector.

During the research, the experimental method was used to implement the developed strategies to optimize the management of big data analytics. For practical demonstration of the strategies, a programme was implemented using delivery route optimization, which performed clustering of delivery points and visualization of the results. This programme is written in Python programming language in the Replit environment. It works in such a way that after generating random coordinates of delivery points, it applies a clustering algorithm to determine the optimal routes. Clustering allows delivery points to be grouped into clusters so that the distance between points within a cluster is minimized and the distance between clusters is maximized. The software then visualizes the initial delivery points and the clustering results in a graph where each cluster is marked with a different colour to provide a visual representation of the optimal delivery routes. The programme saves the graph with the clustering results to a file for easy analysis and visualization of the results. The

experiment was also used to create a scheme illustrating the main stages of the developed strategies. The scheme included analysis, selection, implementation, integration, optimization, and refinement.

The comparison method was applied to evaluate the effectiveness of big data analytics management strategies in logistics. For this purpose, a comparison table including different logistics companies was developed. This table compared the companies on the basis of their functional capabilities, volume and quality of data, results obtained in the application of big data analytics and scope of operations. The comparison of the data presented in the table allowed identifying the main advantages and disadvantages of each company in the use of big data analytics in logistics. This approach helped to systematise the information and provide a better understanding of which data management strategies are most effective for different logistics companies.

RESULTS

Logistics plays a key role in ensuring the smooth operation of many industries. As transport volumes grow and supply chains become more complex, companies are faced with the need to process and analyse huge amounts of data. In this context, big data analytics becomes an indispensable tool for optimizing logistics operations and increasing their efficiency. To gain a deeper understanding of the role of big data analytics in logistics management, it is worth paying attention to real examples of its application in large companies (Table 1).

Table 1. Comparative table of the use of big data in companies

Company	Functional features	Data	Results	Industry
Walmart	Demand forecasting, route optimization, warehouse stock management	Historical sales data, weather data, traffic data, customer geolocation data	Reduction of logistics costs by 20%	Retail trade
Amazon	Route optimization, demand forecasting, personalization of offers	Order data, customer location data, product data, weather data	Leadership in the e-commerce market	Electronic commerce
Dalsey, Hillblom, Lynn (DHL)	Monitoring the condition of the cargo, tracking its movement, forecasting the delivery time	Data from sensors, data about routes, data about weather conditions, data about customs procedures	Improving the quality of customer service	Logistics
United Parcel Service (UPS)	Route optimization, delivery time forecasting, warehouse stock management	Data on orders, data on routes, data on vehicles, data on customs procedures	10% reduction in delivery time	
FedEx	Optimization of routes, forecasting of demand, management of warehouse stocks, forecasting of customs procedures	Data on orders, data on customs procedures, data on security, data on road traffic	Increasing the efficiency of logistics operations by 15%	
XPO Logistics	Route optimization, demand forecasting, warehouse stock management	Data about orders, data about routes, data about vehicles	Reduction of logistics costs by 20%	
Maersk Line		Data on orders, data on routes, data on vehicles, data on weather conditions	Increasing the efficiency of logistics operations by 10%	
Kuehne+Nagel		Data about orders, data about routes, data about vehicles	Reduction of logistics costs by 15%	

Source: made by the author based on Maersk Data Integrations (n.d.), Z. Blank (2021), M. Garland (2022; 2024)

Retail giant Walmart uses big data analytics to forecast demand, optimize delivery routes and manage inventory. The implementation of such technologies has resulted in a 20% reduction in logistics costs (Garland, 2024). Amazon, the global leader in e-commerce, is actively applying big data management to optimize delivery routes, forecast demand and personalise offers for customers (Garland, 2022). This has allowed Amazon to establish itself as a leader in the e-commerce market. DHL, one of the world's largest logistics service providers, uses big data analytics to monitor shipment status, track its movement and predict delivery times (The real value of IoT…, n.d.). This has helped to improve customer service.

UPS uses these analytics to optimize delivery routes, predict delivery times and manage inventory (Tatlidil, 2023). As a result, the company has reduced delivery time by 10%. FedEx also uses big data management to optimize delivery routes, forecast demand and manage inventory (Blank, 2021). This has enabled the company to improve the efficiency of its logistics operations by 15%. XPO Logistics applies big data analytics to optimize delivery routes, demand forecasting and inventory management (How data and digitisation…, 2020). As a result, the company has reduced logistics costs by 20%. Maersk Line also uses big data analytics to optimize delivery routes, demand forecasting and inventory management (Maersk data integrations, n.d.). This has enabled the company to improve the efficiency of its logistics operations by 10%. In addition, Kuehne+Nagel applies big data analytics to optimize delivery routes, demand forecasting and inventory management, which has reduced logistics costs by 15% (Digitalisation in logistics, n.d.).

Thus, analyses of the application of big data in logistics have revealed widespread use of this tool by leading companies in the industry. The results include cost reductions, increased efficiency, and improved customer service. It can be highlighted that the leaders in this area are Walmart, Amazon, DHL, DHL, UPS, and FedEx. However, there

are many other companies using big data in logistics management. In order to realise the research objective, certain methods should be developed to improve the management of big data analysis in logistics (Fig. 1).

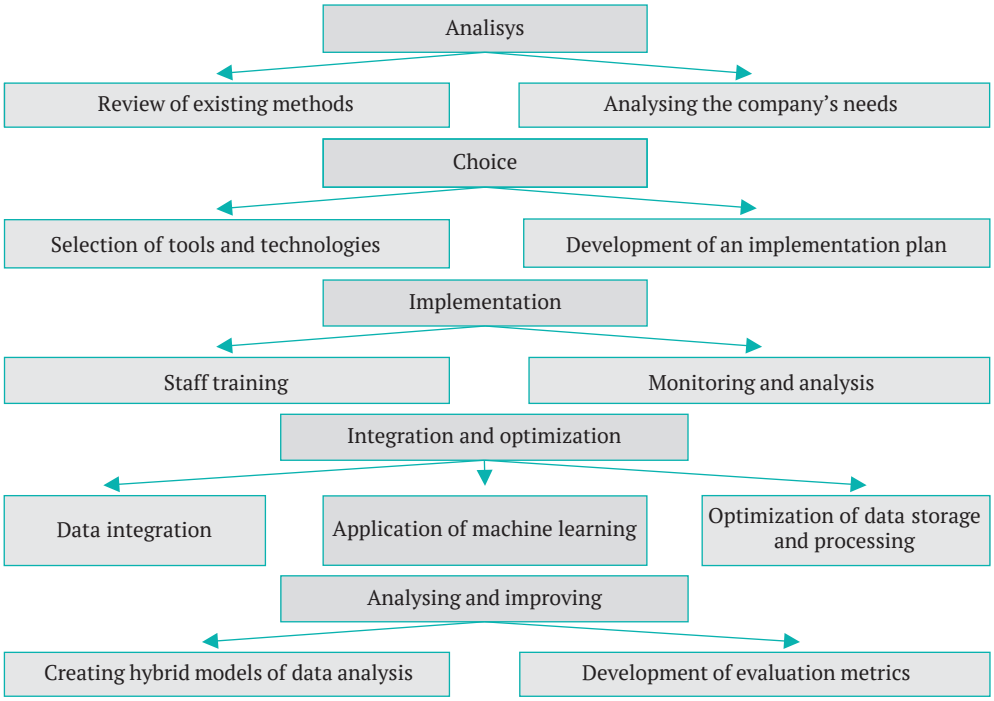

Figure 1. Scheme for improving the management of big data analysis in logistics
Source: made by the author

First, it is necessary to conduct an overview of existing methods that contribute to the improvement of the management of big data analysis in the field of logistics. This will allow determining the most effective strategies and approaches that can be implemented in practice. It is necessary to analyse the needs and peculiarities of a specific logistics company. This stage will help to develop individual optimization strategies that will best meet the requirements and goals of the company. Next, it is necessary to choose the most suitable tools and technologies for optimizing the management of big data analysis in a specific company. It is important to take into account the specifics of business processes and the peculiarities of collected data when choosing such tools.

The next step is to develop a plan for implementing the selected strategies and tools. Determining the stages and terms of implementation, as well as those responsible for their implementation, will help ensure the effective implementation of new methods. One of the key aspects is providing personnel training in the use of new tools and technologies. Trained and competent personnel are the key to successful implementation of innovations in the company's work processes. It is also necessary to establish a system of monitoring and analysis of the results of implementation of optimization strategies. This will make it possible to quickly identify problems and adjust plans if necessary, ensuring constant improvement of processes. In addition, it is important to integrate data from various sources to create a single information base. This will make the analysis more complete and accurate, which will increase the quality of the decisions made.

The next step could be the use of machine learning algorithms to automate the processes of data analysis and trend forecasting in logistics. This will help reveal hidden patterns and optimize business processes. It is necessary to develop methods and technologies to optimize the processes of storing and processing large volumes of data. This will increase the speed and efficiency of the analytics system, reducing time spent. One of the promising directions is the creation of hybrid data analysis models that combine various methods, such as statistical methods, machine learning, and artificial intelligence. This will help to obtain more accurate and reliable analysis results. An important stage is the development of a system of metrics and indicators that will allow assessing the effectiveness of management of big data analysis in logistics, which will help identify areas for further improvement and optimization of processes. Thus, the implementation of the described methods and strategies will allow not only improving the management of big data analysis in the field of logistics, but also ensuring the long-term efficiency and competitiveness of the company.

It is worth concluding that improving the management of big data analysis can significantly increase the efficiency of logistics operations and improve the company's competitive position. For a more in-depth study of the applied strategies, it is worth conducting a practical test of them. For example, develop a simple Python programme that optimizes delivery routes using a clustering algorithm and visualizes the results. This code creates random delivery points, then clusters them using the k-means algorithm and visualizes the results (Fig. 2).

```
import numpy as np
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans

# Generate random coordinates of delivery points
np.random.seed(0)
delivery_points = np.random.rand(30, 2)

# Visualization of starting delivery points
plt.scatter(delivery_points[:, 0], delivery_points[:, 1], color='blue')
plt.title('Clustering of delivery points')
plt.xlabel('Latitude')
plt.ylabel('Longitude')
plt.show()

# Optimizing routes using clustering
num_clusters = 5
kmeans = KMeans(n_clusters=num_clusters)
kmeans.fit(delivery_points)
centroids = kmeans.cluster_centers_

# Visualization of clustering results
colors = ['red', 'green', 'orange', 'purple', 'yellow']
for i in range(num_clusters):
  cluster_points = delivery_points[kmeans.labels_ == i]
  plt.scatter(cluster_points[:, 0], cluster_points[:, 1], color=colors[i])
  plt.scatter(centroids[i][0],
        centroids[i][1],
        color='black',
        marker='x',
        s=100)
plt.title('Clustering of delivery points')
plt.xlabel('Latitude')
plt.ylabel('Longitude')
plt.show()

# Saving analysis results
plt.scatter(delivery_points[:, 0], delivery_points[:, 1], color='blue')
for i in range(num_clusters):
  cluster_points = delivery_points[kmeans.labels_ == i]
  plt.scatter(cluster_points[:, 0], cluster_points[:, 1], color=colors[i])
  plt.scatter(centroids[i][0],
        centroids[i][1],
        color='black',
        marker='x',
        s=100)
plt.title('Clustering of delivery points')
plt.xlabel('Latitude')
plt.ylabel('Longitude')
plt.savefig('delivery_clusters.png')
```

Figure 2. Created code

Source: made by the author

That is, this programme is an example of practical implementation of delivery route optimization, which is related to the management of big data analysis in the field of logistics (Fig. 3).

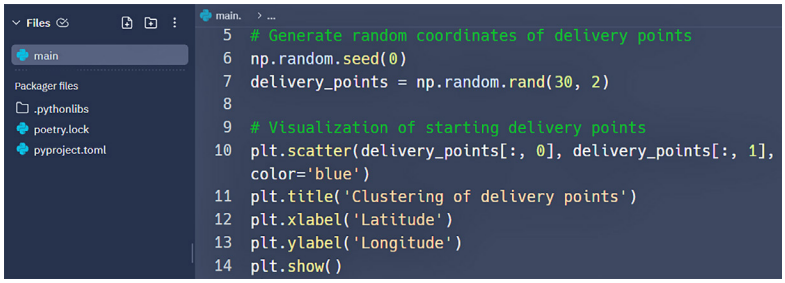

Figure 3. Code fragment in the Replit environment

Source: made by the author

This code demonstrates the application of machine learning methods to optimize logistics processes. The output of the programme is a graphical representation of optimal delivery routes, which allows logistics companies to make more informed decisions when planning routes and optimizing delivery (Fig. 4).

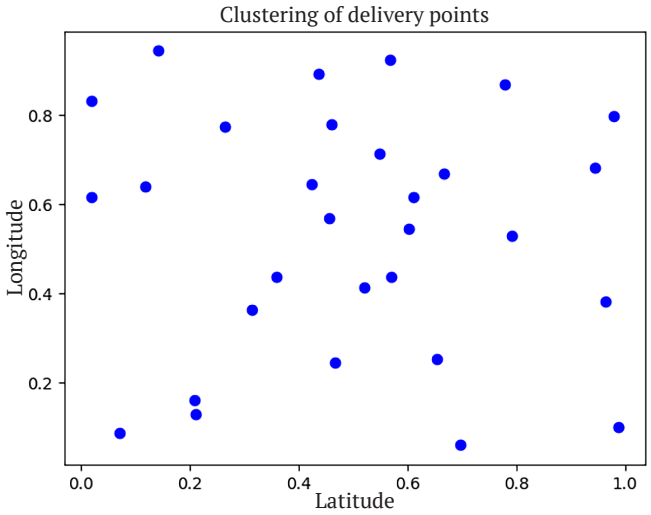

Figure 4. Result of the programme

Source: made by the author

That is, the programme first generates random coordinates of delivery points. Then it applies a clustering algorithm (in this case k-means) to determine the optimal delivery routes. Clustering groups delivery points into clusters such that it minimises the distance between points within a cluster and maximises the distance between clusters. Further, it visualises the initial delivery points and clustering results in a graph. Each cluster is marked with a different colour and the centres of the clusters are marked with crosses. And it saves the graph with the clustering results to the file delivery_clusters.png.

In addition to software development, it is also possible to implement strategies to optimize the management of big data analysis by conducting pilot projects in the real environment of a logistics company. This will test the effectiveness of the strategies in practice and identify potential problems. Training workshops and seminars can be organised for company employees to improve their skills in working with data and applying new analysis methods. A necessary step would be the introduction of a monitoring and evaluation system, which would allow constantly analysing the effectiveness of the applied strategies and make adjustments if necessary.

Considering the research conducted, it is worth providing certain recommendations. Effective management of big data analysis in logistics requires a comprehensive approach that includes analysing existing methods, adapting them to the needs of a particular company, selecting optimal tools and technologies, developing an implementation plan, staff training and a system for monitoring results. It is important to analyse the needs and peculiarities of a particular logistics company before developing and implementing strategies to optimize the management of big data analysis. This will identify the key aspects that should be considered when selecting analysis methods and tools.

The application of machine learning techniques, such as clustering or predictive algorithms, can significantly improve the efficiency of logistics processes. However, it is necessary to choose the appropriate methods wisely and adapt them to the specific conditions of the company. An important step is also the creation of a system for monitoring and analysing the results of the implementation of optimization strategies. This will allow promptly identifying problems and adjusting strategies according to the company's needs. For long-term efficiency and competitiveness of the company it is recommended to constantly improve the processes of big data analysis management, as well as to implement new methods and technologies in accordance with the changing needs of the market and the development of technology. Thus, the implementation of the obtained methods and strategies will not only improve the management of big data analysis in the field of logistics, but also ensure the long-term efficiency and competitiveness of the company.

DISCUSSION

The methods of optimizing the management of big data analysis in the field of logistics were considered, existing approaches were analysed, the needs and characteristics of companies were identified, optimal tools and technologies were selected, and an implementation plan was developed. For a deeper understanding of the research topic, it is necessary to analyse the results of other studies with similar problems. For example, S. Shaikh *et al.* (2023) emphasised that e-commerce plays an important role in the global economy, requiring the development of effective web applications to meet the increasing demand for services and products. The study shows the importance of using technologies such as MongoDB, Node.js and Express.js in building flexible and scalable e-commerce applications. The authors also explored the application of big data analytics in logistics and supply chain management, highlighting innovative methods and practices in this area. The findings provide a better understanding of how modern technology,

and analytics can improve the efficiency of logistics operations and supply chain management. While both studies highlight the importance of using modern technology, each study focuses on different aspects. The current study on logistics management focuses on optimizing data management, while the analysed work highlights the importance of creating flexible applications.

X. Li (2024) highlights that the use of big data analytics in logistics helps to optimize delivery processes, reduce costs, and improve service quality. This proves the relevance of the research in the application of big data analytics to improve logistics management and sustainability. Both studies highlight the relevance of applying big data analytics in logistics to improve business performance and operations, and indicate that the use of big data analytics helps to optimize delivery processes and reduce costs. However, while the study by X. Li (2024) focuses on the general importance of big data analytics in the field, the study on logistics management provides specific strategies for optimizing big data analytics, which enables more efficient solutions to complex problems and high logistics performance. Thus, this study goes beyond general recommendations by providing valuable tools and techniques to improve big data management in logistics.

The study by R. Mishra *et al*. (2023) evaluates the impact of big data analytics on omnichannel logistics and identifies the most important factors affecting this field. A survey was conducted and a case study was conducted to identify the key aspects of this logistics. The results showed that effective information management is a critical factor that can improve omnichannel logistics. It emerges that both papers consider the impact of big data analytics on logistics, although they focus on different aspects. The current study looks at the field of logistics in general, while the other paper focuses solely on omnichannel logistics.

Authors P.V. Pawar & R.A. Paluri (2022) discussed that the amount of data produced by various sectors has increased dramatically, which creates challenges in processing it for professionals. The study aims to analyse the sources and applications of big data analytics in logistics and supply chain management through bibliometric analysis. The study also identifies the benefits of using big data analytics and categorises the trends and research directions in the field. The common aspects of both studies are to explore the problem of data growth and its impact on logistics and management professionals. However, the current study on logistics management focuses on specific strategies for optimizing data management in logistics, which makes it more valuable for developing effective solutions in this area. Thus, this approach is different in that it proposes specific methods to optimize data management, which can lead to more effective solutions in this field.

Researchers M.A. Al Doghan & V.P. Kaliani Sundram (2023) studied how the application of artificial intelligence and big data analysis affects resource management and waste management in Saudi Arabian industry. The study also evaluates the role of plant efficiency and the impact of integrating environmental processes on this process. The results provide insights into how the use of new technologies can improve resource management efficiency and reduce waste in industry. Both studies turn to analysing the impact of big data analytics on management, but the current study delves into big data analytics specifically in the field of logistics management. Although both studies address the topic of big data analytics in management, the current paper's approach focuses on developing strategies to optimize data management, which can bring more practical benefits in the field of logistics.

S.D. Kurniawan *et al.* (2024) examined the basic concepts of big data, the benefits and challenges of its use, and the technologies that enable the management and analysis of big data. In addition, the authors analysed examples of big data usage in different industries and reflected on the future challenges and opportunities of this field. Both studies recognise the significance of big data analysis, but while the above-mentioned study looks at its application in general, the study on logistics management delves into specific methods and strategies to optimize data management in the field of logistics. Thus, the current study offers a deeper and more specific view on the use of data in logistics management, making it a more valuable tool for developing effective strategies in the field.

L.Y. Xiang *et al.* (2021) emphasised that the impact of big data analytics on global companies is creating new opportunities for data-driven decision making across industries and business functions. Big data analytics promises to improve performance in logistics and supply chain, although many companies are not yet utilising it to its full potential. The 2021 study also emphasises the growing importance of big data analytics and its potential impact on the logistics industry, similar to this study. However, unlike the current study, it does not provide specific strategies to optimize the management of big data analytics in logistics, focusing mainly on general theoretical aspects. This allows seeing that the study on logistics management stands out with a more practical approach, which makes it a valuable tool for developing specific ways of optimization in the field of logistics.

In addition, Y.-T. Chen *et al.* (2021) emphasised that when studying the vehicle routing problem, travel time determination plays a crucial role in optimizing logistics companies. IoT for transportation collects data from various sources to analyse the current traffic status in real time and improve the efficiency of logistics management. However, IoT big data analysis has complex and interconnected characteristics, which makes travel time determination based on real data unpredictable. The study proposes a new travel time prediction method based on IoT data, which successfully improves the accuracy of time prediction after comparing with other computational methods. The common aspects in both papers are that they highlight the importance of using data to optimize logistics processes. However, while this study focuses on a broad analysis of the directions of application of big data in logistics and proposes methods to optimize the management of this data, the analysed work focuses on the specific task of travel time prediction based on IoT data to improve transport routing.

Authors A. Wahyudin *et al.* (2023) pointed out that big data analytics technology can improve supply chain monitoring by increasing the flexibility of logistics companies. Information management systems generate data from different sources and formats. The development of big data analysis uses the method of rapid software development, which is suitable for solving complex problems in logistics.

That is, both studies draw attention to the significance of big data analysis technology in logistics management and its ability to improve supply monitoring and increase the flexibility of logistics companies. The study on logistics management focuses on developing specific methods to optimize the management of big data analytics in logistics, allowing a deeper understanding of the potential of this technology and applying it more effectively. While the 2023 study discusses the general benefits and challenges of using big data analytics technology without delving into specific optimization methods, making its approach more generalised and less applicable in practice.

Researchers A. Kwasek & D. Prokopowicz (2023) discussed that information technology and Industry 4.0 are important for the development of knowledge in the economy. Their use improves management and logistics processes in companies. Data analysis allows for more efficient production management and risk control. The study analyses the impact of these technologies on organisation and management in Poland. Both projects emphasise the importance of information technologies, including big data analytics, in improving management and logistics processes in companies. However, the study of 2023 discusses the overall impact of IT and Industry 4.0 on organisation and management in Poland. One of the main differences is also the focus and highly specialised analysis in this study, while the other study looks at the broader context and general trends in IT development.

In their paper, C. Liu *et al*. (2020) proposed an innovative IoT-based Cloud Laundry business model for mass laundry service. This model utilises big data analytics and machine learning techniques to provide efficient and convenient services to customers. The study on the application of big data analytics in logistics management focuses on optimizing data management in logistics, while the 2020 study on the Cloud Laundry business model describes the use of data analytics to optimize industry-specific IoT-based services. The study presents valuable examples of using data analytics to improve business processes, and this strategy can consider the results for better data management in logistics.

Author A. Abbas (2024) investigated the use of big data analytics and machine learning in mergers and acquisitions and information technology supply chain. He concluded that organisations can improve decision-making processes, optimize operational efficiency and gain competitive advantage by applying these technologies. The implication is that both studies address the application of big data analytics, but their focuses are different. The study on logistics management focuses on improving data management in logistics, while the mentioned study by A. Abbas (2024) examines the application of data analytics and machine learning in M&A and information technology supply chain. It is important to note that both approaches have their relevance and applicability in their respective fields, but this strategy focuses on specific methods to optimize data management in logistics, which may be more relevant to address the specific problems and challenges faced by logistics companies.

Finally, N. Novanda & H. Medyawati (2023) noted that logistics plays an important role in enabling corporate commerce by providing the necessary services to deliver goods from producers to consumers. The study aims to analyse the impact of service quality, price perception and promotion on consumer satisfaction with Shopee Xpress service and identify the most influential factors. The author used partially least squares method and data was collected using questionnaire instruments. The results showed that service quality and promotion affect customer satisfaction but price perception has no influence on it, the most important factor is promotion. In contrast to this paper, the 2023 study focuses on a specific service and determines which variables are most significant for consumer satisfaction in this area.

Thus, all the reviewed studies confirm the significance of using big data analytics to optimize management processes and improve business performance, including the field of logistics management. However, each of them highlights unique aspects of the application of these methods and technologies in a particular area, which emphasises the diversity of approaches and the potential of big data analytics in modern business.

CONCLUSIONS

The study analysed the topical aspects of big data management and analysis in logistics. The results showed that big data analytics plays a key role in optimizing logistics management processes, improving productivity and supply chain efficiency. The main findings of the study include the development of strategies to optimize logistics management using big data analytics. A programme has been created that effectively optimizes delivery routes using clustering algorithms and shows the results of this process. An informative diagram has been developed that clearly illustrates the key steps of the resulting strategies. A table describing the application of big data analysis techniques in various logistics companies was compiled. This table compared the companies based on their functional capabilities, data, results, and scope. The analysis showed that the use of machine learning techniques and optimization of data storage and optimizing processes significantly improves the efficiency of logistics operations.

Based on the findings, certain recommendations can be offered. For example, to develop and implement software solutions based on big data analysis, as well as to use machine learning methods to create predictive models. IoT technologies should be implemented to collect real-time data on equipment status and transport conditions, and data security should be strengthened by implementing appropriate security measures and encryption. Training and development of company personnel in big data analytics and modern technologies should be provided so that they can effectively use tools to improve logistics processes. Implementation of the proposed recommendations will allow logistics companies not only to improve operational efficiency, but also to reduce costs by optimizing logistics processes and demand forecasting. This also contributes to improved customer service through more accurate planning and supply management, which will significantly enhance their competitiveness in the market.

For further research in the field of logistics and big data analysis, it is recommended to study in-depth the application of artificial intelligence and automated systems in the management of logistics processes. It is also important to investigate the impact of new technologies such as

blockchain and virtual reality on the optimization of logistics systems. Additionally, it is worth analysing the effectiveness of using big data analytics and machine learning methods in different logistics industries to identify the most effective strategies and approaches.

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CONFLICT OF INTEREST

None

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Напрями застосування Big Data аналітики в логістичному менеджменті

Дінара Булатівна Аубакірова
HR-менеджер
ТОВ ZALMA Ltd.
050009, вул. Богенбай батира, 305А, м. Алмати, Республіка Казахстан
https://orcid.org/0009-0000-8878-7570

Анотація. Логістичні операції стають дедалі складнішими та вимагають точних даних для ефективного управління. Використання Big Data в логістичному менеджменті є актуальною темою у зв'язку зі зростанням обсягу даних і необхідністю оптимізації процесів доставки та управління запасами для задоволення потреб ринку. Метою дослідження була розробка способів оптимізації управління аналізом Big Data у сфері логістики. Для досягнення мети використовувалися методи аналізу, експерименту та порівняння. У результаті дослідження було розроблено та успішно застосовано стратегії оптимізації логістичного управління аналізом Big Data. Створена на мові Python програма ефективно оптимізує маршрути доставки, використовуючи алгоритм кластеризації, й візуалізує результати цього процесу. Додатково, складено інформативну схему, що наочно ілюструє ключові етапи розроблених стратегій. У рамках дослідження також було розроблено та представлено таблицю, що описує застосування методів аналізу Big Data в різних логістичних компаніях. Проведено порівняння компаній за функціональними можливостями, даними, отриманими результатами та сферою діяльності. Встановлено, що використання методів машинного навчання та оптимізації процесів зберігання й обробки даних істотно збільшує ефективність логістичних операцій. Результати цього дослідження можуть бути використані логістичними компаніями будь-якого масштабу, а також підприємствами, що займаються управлінням ланцюгами поставок. Крім того, рекомендації та стратегії, розроблені в рамках дослідження, можуть бути корисними для професіоналів у галузі інформаційних технологій та аналітики даних, які займаються розробкою програмних рішень і систем для оптимізації логістичних процесів

Ключові слова: контроль поставок; використання об'ємної інформації; способи оптимізації управління; транспортно-складська організація; аналіз Big Data